Acronym List

Acronym	Explanation
µg/L	Microgram per Liter
CSM	Conceptual Site Model
DuPont	E.I. du Pont de Nemours and Company
DVM	Data Verification Module
DWQI	Drinking Water Quality Institute
ECF	Electro Chemical Fluorination
EPA	U.S. Environmental Protection Agency
F	Fluoride
GAC	Granular Activated Carbon
H	Hydrogen
HA	Health Advisory
HF	Hydrogen Fluoride
LCS	Laboratory Control Spike
LCSD	Laboratory Control Spike Duplicates
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NEtFOSAA	N-ethyl perfluorooctanesulfonamidoacetic acid
ng/L	Nanograms per Liter
NJAW	New Jersey American Water
NJDEP	New Jersey Department of Environmental Protection
NJGWIIA	New Jersey Groundwater Class IIA Standards
NMeFOSAA	N-methyl perfluorooctanesulfonamidoacetic acid
OM&M	Operations Maintenance and Monitoring
PFAI	Perfluoroalkyl Iodides (also known as Telomer A)
PFAS	Per- and Polyfluoroalkyl Substances
PFEI	Pentafluoroethyl Iodide
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PPI	Private Personal Information
PWS	Public Water Supply
QA/QC	Quality assurance/quality control
QAPP	Quality Assurance Project Plan
RPD	Relative Percent Differences
SOP	Standard Operating Procedure

1.0 Introduction

This report summarizes the status and findings of the ongoing 2016 Residential Drinking Water Well Surveying and Per- and Polyfluoroalkyl Substances (PFAS) Sampling Program (ongoing 2016 program) conducted in the vicinity of the Chemours Company [Chemours; formerly E.I. du Pont de Nemours and Company (DuPont)] Chambers Works Complex (Chambers Works) located in Deepwater, New Jersey (see Figure 1). The primary purpose of this investigation is to evaluate the presence and distribution of 14 PFAS in residential drinking water wells in the vicinity of Chambers Works. This program is a follow-up to the 2009 Residential Drinking Water Well Surveying and Sampling Program that was conducted by DuPont within a 2-mile radius of Chambers Works (the 2009 program), the purpose of which was to evaluate the presence and distribution of perfluorooctanoic acid (PFOA), one PFAS compound, in residential drinking water wells within two miles of Chambers Works.

1.1 Background

PFAS are a diverse group of compounds that are resistant to heat, water, and oil. PFAS have been used in both industrial applications and consumer products such as carpeting, upholstery, apparel, and fire-fighting foams. At Chambers Works, PFAS and precursors to PFAS (i.e., fluorotelomer alcohols) have been used in the production of fluoroelastomers, fluorotelomers, and have also been unintentionally created within manufacturing processes and waste streams. As described in the *Conceptual Site Model (CSM) for Poly- and Perfluoroalkyl Substances (PFAS) for the Chambers Works Complex* (PFAS CSM report; AECOM, 2017a), migration pathways for the movement of PFAS from sources to off-site environmental media receptors include air emissions and downwind movement of PFAS from stacks and vents used during the manufacturing processes. The use of PFOA in all perfluoroelastomer manufacturing was discontinued in 2013. However, some historical PFAS-containing air emissions may have migrated to off-site soils where PFAS may have leached into groundwater by way of precipitation. Groundwater is the drinking water source for many residents in the vicinity of Chambers Works.

In addition to the known on-site PFAS sources that may have migrated to off-site groundwater, other potential sources for PFAS in residential drinking water wells, unrelated to Chambers Works, were identified in the Chambers Works PFAS CSM report. Figure 2 provides the conceptual cross section for the local off-site area with potential PFAS sources that is presented in the PFAS CSM report. As shown in Figure 2, these include the use and disposal of consumer and industrial products that contain PFAS, such as stain-resistant treatments on upholstery and carpets, cleaning products, fire extinguishers, and many other common items that frequently are present in homes and businesses and which could also contribute to PFAS in residential drinking water wells. In addition, there may be known and potential PFAS contributions from nearby industries, airports, fire stations and fire training area activities, and fire-fighting activities related to automobile accidents on the three major highways that cross the area. As an example of one such accident, on June 15, 2018 a bus caught on fire on the New Jersey Turnpike in the vicinity of Chambers Works and the Chemours investigation area as it was approaching the Delaware Memorial Bridge (http://6abc.com/traffic/bus-fire-slows-traffic-on-nj-turnpike-in-salem-co/3604946/). Included in the news story are videos showing the use of foam for fire suppression, including images of the foam migrating to the grass median.

1.2 Purpose and Objectives

The purpose of the ongoing 2016 program is to evaluate the presence and distribution of PFAS in residential drinking water wells in the vicinity of Chambers Works. The objectives of the various phases of the investigations are as follows:

- Survey residences in the vicinity of Chambers Works and identify wells used as drinking water sources.
- Offer sampling to homeowners who use drinking water wells.
- Analyze the samples for the 14 PFAS (the ongoing 2016 program) and for branched and linear PFOA, PFOS and PFNA (branched/linear study) in select samples.
- Compare the PFAS results against applicable screening criteria.
- Offer treatment to owners of drinking water wells that exceed the applicable screening criteria.
- Install granular activated carbon (GAC) treatment systems, connect the resident to the public water supply (PWS), if practical, or provide permanent bottled water, as appropriate, to reduce exposure to PFAS from drinking water.
- Provide installed GAC treatment system operation maintenance and monitoring (OM&M) on a quarterly basis.
- Evaluate the results to determine the following:
  - If expansion of the ongoing 2016 program survey area is warranted
  - If evidence of the potential for PFAS sources unrelated to Chambers Works is observed

The objectives of this report are as follows:

- Provide an updated status of the current phase of work completed in Expanded Area 3 and the results finalized through May 11, 2018, and for the ongoing 2016 program overall, including the OM&M program.
- Present the results and observations on the branched/linear PFAS study.
- Propose a path forward.

1.3 Report Structure

The remainder of this report is organized as follows:

- Section 2 provides an update on the investigation recently completed in Expanded Area 3 and an overall status update on the ongoing 2016 program.
- Section 3 describes the sampling methodology, analytical methods, and data quality evaluation, including third-party data validation of the ongoing 2016 program data.
- Section 4 provides the results finalized through May 11, 2018 for the ongoing 2016 program.
- Section 5 provides information on the drinking water wells qualified for treatment under the 2009 and ongoing 2016 programs, the treatment provided, and an update of the ongoing quarterly GAC treatment system OM&M program.

- Section 6 provides a description of the branched/linear study for PFOA, PFOS, and PFNA and presents the results and observations.
- Section 7 presents the conclusions and the proposed path forward.
- Section 8 provides the references cited in this report.

2.0 Residential Drinking Water Well Surveying and Sampling Program Implementation

Implementation and results for previous phases of the ongoing 2016 program, including the 2009 program, the 1- and 2-mile radius investigation, and the investigation of Expanded Areas 1 and 2 (see Figure 3) were described in the *2016-2017 Residential Drinking Water Well Surveying and PFAS Sampling Program Status Update* report that was submitted in September 2017 (AECOM, 2017b). Based on those results, surveying and sampling in new investigation area, Expanded Area 3 (see Figure 3), began in September 2017. Investigation of Expanded Area 3 was closed in early March 2018 for the purposes of conducting data evaluation when the number of residents responding dropped off. However, any homeowner from Expanded Area 3 (or any of the previous investigation areas) that called the Chemours representative were offered sampling, if qualified (see Section 2.3), in the next phase of the investigation. In addition, other phases of work involving offering resampling for select wells with previous results and offering surveying and sampling to potential drinking water well homeowners in Oldmans Township began around that same time. The subsections below provide the results of the completed Expanded Area 3 investigation and the status of the ongoing phases of work included in what is referred to as the "Responses After March 9, 2018" program. In addition, an overall ongoing 2016 program summary is provided in the last subsection.

2.1 Expanded Area 3 Investigation

The Expanded Area 3 investigation began in September 2017 with the development of the homeowner contact list and concluded with analytical results finalized and mailed by March 26, 2018. Because this was a new investigation area, a mailing list was developed by field reconnaissance and the use of tax maps as described in Section 2 of the Standard Operation Procedures (SOPs) submitted to U.S. Environmental Protection Agency (EPA) and New Jersey Department of Environmental Protection (NJDEP) on May 15, 2018 for the implementation of the ongoing 2016 Program (ongoing 2016 program SOPs). Three letters were mailed three weeks apart to each homeowner included in the contact list (see an example of the letters that were mailed in Appendix A). Letters received as "return to sender" were evaluated and alternative names and or address for the homeowner were used for the next mailing as described in Section 2 Step 3 of the ongoing 2016 program SOPs. A spreadsheet titled "Expanded Area 3" was used to track homeowner contacts. That spreadsheet was provided to EPA and NJDEP on an ongoing basis prior to status update meetings and is provided here as Appendix B[3]. In addition, any homeowner who called the Chemours representative while the Expanded Area 3 investigation was ongoing that had a well located in any of the previous investigation areas, regardless of whether or not they had received a letter from Chemours, was also included in this tracking spreadsheet. Within the Expanded Area 3 spreadsheet:

- 186 residents were mailed letters offering sampling or called.
- 101 homeowners called the Chemours representative.

[3] Specific homeowner information such as name, address, and telephone number is Private Personal Information (PPI) and is not included in Appendix B of this report but is included as a separate paper copy associated with this report marked "Private Personal Information (PPI) – Do Not Release."

- 13 homeowners either had no water at the residence, had public water, or declined sampling (see white rows in Appendix B).
- 88 drinking water wells were sampled (see blue rows in Appendix B).
- 53 homeowners appear to have received all three letters, but have not responded to Chemours' offer of drinking water well sampling (see green rows in Appendix B).
- 12 addresses were "return to sender," and the alternative names/addresses were used and the mailing did not come back as return to sender so these homeowners are also considered as non-response to the offer (see green rows in Appendix B).
- 20 addresses were "return to sender," and alternate names/address did not resolve the issue and these homeowner contacts were shared with EPA and NJDEP (see pink rows in Appendix B).

The 88 drinking water wells sampled were analyzed for 14 PFAS (see Table 1 for the complete analyte list and see Appendix C for the results for all 14 PFAS). Based on agreement between Chemours, EPA, and NJDEP, results for the three PFAS for which there are applicable screening criteria, Perfluorononanoic Acid (PFNA), PFOA, and Perfluorooctane Sulfonate (PFOS), were compared to the applicable criteria shown below:

- The New Jersey Groundwater Class IIA (NJGWIIA) groundwater quality criterion for PFNA of 0.01 micrograms per liter (µg/L). As of March 29, 2018, the PFNA criteria applied by Chemours changed to the New Jersey Drinking Water Quality Institute's (DWQI's) recommended drinking water standard of 0.013 µg/L, which was accepted by NJDEP in November 1, 2017.
- EPA's 2016 Lifetime Health Advisory (HA) for PFOA and PFOS of 0.07 µg/L. If both PFOA and PFOS are detected in a drinking water well, the individual PFOA and PFOS concentrations and the sum of PFOA and PFOS concentrations were compared to the HA of 0.07 µg/L.
- The New Jersey DWQI's recommended drinking water standard of 0.014 µg/L for PFOA, which was accepted by NJDEP in November 1, 2017. When the Expanded Area 3 investigation began in September 2017, the screening criteria applied for PFOA was the NJDEP preliminary health-based guidance for PFOA in drinking water value of 0.04 µg/L, which had been used for screening all PFOA results for samples collected for previous phases of the ongoing 2016 program. In November 2017, the criteria of 0.014 µg/L was applied at the request of EPA and NJDEP. Results from all previous phases of the ongoing 2016 Program, including Expanded Area 3, were then rescreened against the recommended drinking water standard of 0.014 µg/L for PFOA, and all homeowners with PFOA results between 0.014 µg/L and 0.04 µg/L were then offered treatment.

The results for PFOA, PFOS, and PFNA in the 88 drinking water wells sampled are provided in Table 2 and are discussed in Section 4 along with results for other samples collected during the 2009 Program and the ongoing 2016 program. Of the 88 well results screened against the criteria, 62 are qualified for treatment to reduce exposure to PFAS from the drinking water. However, one of these wells was no longer being used because the homeowner connected the residence to a PWS while waiting for the well sampling results and Chemours subsequently reimbursed her for the connection costs. Section 5

provides further discussion of the qualified drinking water wells, the status of treatment offered, and the ongoing quarterly OM&M program.

Of the 26 wells not qualified for treatment, additional resampling offers may be made based on the results as described in Section 3 of the ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the ongoing 2016 Program SOPs.

2.2 Resampling Offered for Select Wells Sampled in the 2009 Program

At the February 14, 2018 quarterly Chambers Works update meeting with EPA and NJDEP, Chemours agreed to recontact homeowners whose wells were sampled in the 2009 program and had PFOA results greater than 0.014 µg/L, but less than 0.4 µg/L (the EPA criteria in 2009), and the homeowner did not respond to the ongoing 2016 program's offer to sample. Chemours agreed to send an additional letter to these 28 homeowners and EPA agreed to attempt to follow up with a phone call. Letters were mailed to these homeowners on February 26 or March 5, 2018. Residential contacts for this group of residents are tracked in Responses After March 9, 2018 program spreadsheet that is provided to EPA and NJDEP on an ongoing basis prior to status update meetings. The May 11, 2018 version of the spreadsheet is provided here as Appendix D[4] (see "2009 Revisit Folks" in the program column). As of May 11, 2018, six of these homeowners have responded to the Chemours representative. Of these six:

- One drinking water well was already in progress for GAC installation, as the well had been sampled already as part of the ongoing 2016 program
- One resident notified EPA that his well was not currently being used as the well pump was broken and that he would recontact EPA when the well is able to be sampled.
- Four wells were sampled. Of these, final results were available for three wells (see Appendix C for the results for all 14 PFAS).

The final results for PFOA, PFOS and PFNA in the three drinking water wells are provided in Table 3 and are discussed in Section 4 along with results for other samples collected during the 2009 Program and the ongoing 2016 program. Two of the three wells are qualified for treatment. Section 5 provides further discussion of the qualified drinking water wells, the status of treatment offered, and the ongoing quarterly OM&M program. An additional resampling offer may be made based on the results to the homeowner of the well unqualified for treatment as described in Section 3 of the ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the ongoing 2016 program SOPs.

2.3 Previous Investigation Area Residents Calling in After March 9, 2018

As noted above, the Expanded Area 3 investigation was closed in early March 2018, when there was a lack of new responses to that sampling offer, so that data evaluation could begin. All homeowners from any of the previous investigation areas, including

[4] Specific homeowner information such as name, address, and telephone number is Private Personal Information (PPI) and is not included in Appendix D of this report, but is included as a separate paper copy associated with this report marked "Private Personal Information (PPI) – Do Not Release."

Expanded Area 3, that called the Chemours representative after March 9, 2018 are tracked in the Responses After March 9, 2018 program and spreadsheet, are identified as "After March 9" in the program column (see Appendix D).

As of May 11, 2018, eight residents contacted during previous phases of the ongoing 2016 program called in and all had wells that were sampled. One resident had installed a new well and requested sampling of the new well. In addition, one resident who had not received a letter from Chemours called in and that well was sampled. All nine results are final and four of the wells sampled are qualified for treatment. The results for PFOA, PFOS, and PFNA in the nine drinking water wells sampled are provided in Table 3 and in Appendix C and are discussed in Section 4 along with results for other samples collected during the 2009 Program and the ongoing 2016 program. Section 5 provides further discussion of the qualified drinking water wells, the status of treatment offered, and the ongoing quarterly OM&M program. An additional resampling offer may be made based on the results to the homeowner of the five wells unqualified for treatment as described in Section 3 of the ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the ongoing 2016 program SOPs.

In addition, the Village of Auburn PWS was sampled. However, only one of the two production wells was operating at that time and the results for that well are not yet final. The second production well sample and a finished water sample will be collected in the future at the convenience of the PWS operator.

2.4 Chemours March 29, 2018 Additional Commitments

On March 29, 2018, Chemours made commitments to take additional actions to recontact homeowners whose wells had been sampled previously and whose results fell into specific concentration ranges and homeowners that were non–responsive to Chemours sampling offers. These actions were completed and residential contacts are tracked in the Responses After March 9, 2018 program and spreadsheet provided to EPA and NJDEP on an ongoing basis prior to status update meetings (see Appendix D) and included the following:

- Homeowners whose wells were sampled in 2009, with a PFOA result greater than or equal to 0.005 µg/L, but less than 0.014 µg/L, that were not resampled in the ongoing 2016 program, were offered resampling via mailing one letter and then with one phone call. (During implementation, it was determined that there were no residents whose well results fell into this category.)
- Homeowners whose wells were sampled in 2016 and with concentration ranges for PFOA, PFOS, or PFNA as listed below were offered resampling (identified as "2016 5 to 14 Folks" in the program column of Appendix D):
  - PFOA results greater than or equal to 0.005 µg/L but less than 0.014 µg/L;
  - PFOS results or PFOA plus PFOS results greater than or equal to 0.005 µg/L, but less than 0.070 µg/L; and
  - PFNA results greater than or equal to 0.005 µg/L but less than 0.010 µg/L.

  Seven drinking water wells had results that fell into the above criteria ranges. Resampling was offered via one letter mailed April 9, 2018 and one phone call made shortly after that to the three residents with results in the above listed concentration ranges whose wells were sampled more than one year ago. All three of these residents have called in and their wells were resampled; however,

as of May 11, 2018, results are not final. Paths forward for these results will be made based on the results as described in Section 3 or Section 4, as appropriate, of the ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the ongoing 2016 program SOPs.

Resampling of the other four qualified wells that were sampled less than one year ago will be offered via one letter and one phone call during the fourth quarter of 2018 as per the Chemours March 29, 2018 commitments letter.

- Residents who were non-responsive to the sampling offer for any of the phases of the 2016 Program were re-contacted. 145 residents were contacted one more time by letters mailed on April 12, 2018 and were encouraged to participate in the ongoing 2016 Program. These resident's contacts are tracked in the Responses After March 9, 2018 program (identified as "non-response" in the program column) and spreadsheet provided to EPA and NJDEP on an ongoing basis prior to status update meetings (see Appendix D). These residents are identified as "Non-response" in the program column in Appendix D.

  As of May 11, 2018, eight of the 145 non-response residents have contacted the Chemours representative. Of these, four have public water connection and four had wells that were then resampled. Final result were not available for the four wells as of May 11. Paths forward for these results will be made based on the results as described in Section 3 or Section 4, as appropriate, of the ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the ongoing 2016 program SOPs.

- Potential well owners in Oldmans Township that were identified by NJDEP were contacted to offer sampling of qualified wells. Chemours mailed letters to 45 residents in Oldmans Township on either April 10 or 12, 2018. These resident's contacts are tracked in the Responses After March 9, 2018 program (identified as "Oldsman Township list from Dudar" in the program column) and spreadsheet provided to EPA and NJDEP on an ongoing basis prior to status update meetings (see Appendix D).

  Of these 45 residents, as of May 11, 2018, 14 had called the Chemours representative and 13 drinking water wells were sampled and the remaining well sampling was scheduled. No results were finalized as of May 11, 2018. Paths forward for these results will be made based on the results as described in Section 3 or Section 4, as appropriate, of the Ongoing 2016 program SOPs submitted to EPA and NJDEP on May 15, 2018 and upon approval of the Ongoing 2016 program SOPs.

- Chemours also agreed to conduct its own evaluation of the tax maps and NJDEP well database to identify any other potential well owners in Oldmans Township. That evaluation was ongoing as of May 11, 2018.

2.5 Overall Responses After March 9, 2018 Program Summary

As stated in Section 2.2 through 2.4, all residential contacts for those programs are being tracked in the Responses After March 9, 2018 program and spreadsheet. As of May 11, 2018, summary statistics for this program are as follows:

- 235 residents were mailed letters offering sampling or resampling, or called the Chemours representative or will be offered resampling in the fourth quarter of 2018.

- Six residents responded and indicated that they have a PWS connection or a broken well pump or a GAC system installation was in progress (see white rows in Appendix D).
- 35 residents requested sampling (see blue rows in Appendix D):
  - Three wells were scheduled for sampling;
  - 20 wells were sampled, but do not yet have final results; and
  - 12 wells that were sampled have final results: six are qualified for treatment and six are not qualified for treatment.
- Four residents will be sent letters offering resampling in the fourth quarter of 2018 (see green rows with red text in Appendix D).
- 175 residents are non-response to the mailing (see green rows in Appendix D).
- 15 letters have come back as return to sender and follow-up is being conducted as described in Section 2 Step 3 of the Ongoing 2016 program SOPs (see pink rows in Appendix D).

2.6 Overall Ongoing 2016 Program Sampling Summary

For the ongoing 2016 program overall, as of May 11, 2018:

- 303 samples have been collected and have finalized results, representing 255 drinking water wells (see Table 4 and Appendix C).
- Of the 255 drinking water wells, 143 are qualified to receive or have received an offer of treatment and treatment status is discussed in Section 5.

3.0 Sampling Methodology, Analytical Methods, and Data Quality

A draft Quality Assurance Project Plan (QAPP) for the Chemours 2016-2017 program was submitted to EPA and NJDEP on April 19, 2016. Comments on the draft QAPP were received by Chemours on April 29, 2016 and were addressed in the final QAPP dated June 2, 2016. On June 3, 2016, the final QAPP titled *Quality Assurance Project Plan For the PFAS Drinking Water Sampling Program, Chemours Chambers Works, Deepwater, New Jersey* was submitted to Mr. Sin Kie Tjho, the EPA Region 2 Project Manager at that time. The QAPP was also copied to Ms. Linda Range, the NJDEP case manager at that time. The QAPP was approved by Mr. Tjho on June 9, 2016. The QAPP was provided in Appendix E of the *2016-2017 Residential Drinking Water Well Surveying and PFAS Sampling Program Status Update* report that was submitted in September 2017 for reference.

The QAPP was prepared using the Uniform Federal Policy for Quality Assurance Project Plans as requested by EPA and was written to describe policies, project organization, functional activities, and quality assurance/quality control (QA/QC) measures intended to achieve the data quality objectives for sampling activities associated with the drinking water sampling project. The QAPP is intended to meet the requirements for conducting the work in accordance with QA/QC field protocols for collecting environmental measurement data.

This section summarizes the sampling methodology, analytical methods, data quality, and data validation procedures. Detailed information is included in the approved QAPP.

3.1 Sampling Methodology

Drinking water was sampled from taps at residential locations according to the procedure found in QAPP Worksheet #21, taking care to avoid possible sources of PFAS contamination.

Information related to collection of each drinking water sample was recorded on a data collection sheet (see Appendix E of the QAPP) in a sampling book with carbon copy sheets.

Quality control samples were collected as described in QAPP Worksheet #20, including collection of field duplicate samples at better than a frequency of 1 in 20. Extra sample volume from designated sample locations was planned at a frequency of 1 in 20 to allow analysis of laboratory QC samples as matrix spikes (MS) and laboratory replicates as an assessment of precision and accuracy. Where extra volume was not submitted to the laboratory for a given lot of samples, precision and accuracy were measured by laboratory analysis of laboratory control spikes (LCS) and LCS duplicates (LCSD).

Field blank samples were collected by performing a bottle-to-bottle transfer of laboratory blank water during each day of sampling.

3.2 Analytical Methods

Drinking water samples were submitted to TestAmerica Sacramento in West Sacramento, California for PFAS analysis using liquid chromatography tandem mass spectrometry. The laboratory SOP used for analysis can be found in Appendix A of the QAPP.

The target list reported can be found in Table 1 of this report.

The reporting limit for the target list was 2 nanograms per liter (ng/L) in water except for N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) and N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA), which were reported to 20 ng/L.

Laboratory reports provided by TestAmerica can be found in Appendix E.

3.3 Data Quality

Data for the ongoing 2016 program residential samples have been reviewed using the Data Verification Module (DVM). The DVM is an internal review process used to assist with the determination of data usability. The electronic data deliverables received from the laboratory are loaded into the Locus EIM™ database and processed through a series of data quality checks, which are a combination of software (EIM DVM) and manual reviewer evaluations. The data are evaluated against the following data usability checks:

- Field and laboratory blank contamination
- EPA hold time criteria
- Missing QC samples
- MS/Matrix Spike Duplicate (MSD) recoveries and the relative percent differences (RPDs) between these spikes
- LCS/ LCSD recoveries and the RPDs between these spikes
- Surrogate spike recoveries for organic analyses
- RPD between field duplicate sample pairs
- RPD between laboratory replicates for inorganic analyses
- Difference/percent difference between total and dissolved sample pairs.

The DVM applies the following data evaluation qualifiers to analysis results, as warranted.

Qualifier	Definition
R	Unusable result. Analyte may or may not be present in the sample.
B	Not detected substantially above the level reported in the laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected. Reporting limit may not be accurate or precise.
U	Not Detected.

The DVM review process was performed on 100% of the data generated for the sampling events. The DVM review process was supplemented by a manual review of the instrument-related QC results for calibration standards, blanks, and recoveries (see Appendix H of the QAPP) to elevate the overall review process to be consistent with Stage 2b of the EPA Guidance for Labelling Externally Validated Laboratory Analytical Data for Superfund Use (EPA-540-R-08-005, 2009).

Overall, the analytical data are acceptable for use without qualification; however, some analytical results have been qualified in the database. The DVM narrative report for samples collected during 2017 and 2018, beginning with samples collected beginning August 10, 2017 and found in Appendix F, lists which samples were qualified, the specific reasons for the qualification, and the potential bias in reported results.

3.4 Third-Party Data Validation

Approximately ten percent of the residential sample results generated during the ongoing 2016 program residential sampling are planned to be validated by a third party reviewer as described in the QAPP document. Three laboratory lots were previously submitted to be validated by a third-party reviewer, Environmental Standards, Inc., Valley Forge, Pennsylvania for compliance with the laboratory SOP and data usability. Completion of validation for the original three laboratory data packages was delayed but is expected to be complete by the end of June 2018. Additional laboratory lots representing approximately 10% of the residential samples collected will be provided to Environmental Standards, Inc. by the end of June 2018, with completion of validation requested by the end of December 2018. Validation is taking place concurrent with data reporting in order to expedite reporting of results. The National Functional Guidelines will be used as a guide for report formatting and application of qualifiers. A formal report will be generated by the validator, which will include judgments on data usability and data qualifiers applied by the validator. The procedures that the Environmental Standards data reviewers will use to validate PFAS data for this project are described in the Data Validation SOP (see Appendix J of the QAPP).

The validation reports will be shared with EPA when available and upon request.

4.0 Drinking Water Well Results

PFOA results from the 2009 program and PFOA, PFOS, and PFNA results for the ongoing 2016 program are provided in Figures 4A, 4B, and 4C. PFOA results from the 2009 program were provided in Table 1 of the *2016-2017 Residential Drinking Water Surveying and PFAS Sampling Program Status Update* report submitted in September 2017 to EPA and NJDEP. PFOA, PFOS, and PFNA results finalized by May 11, 2018 for the ongoing 2016 program are provided in Table 4 and Appendix C. Figure 4A is an index map showing the aerial extents of Figures 4B and 4C. Data shown in Figures 4B and 4C are presented by the drinking water well addresses.

Drinking water wells sampled are indicated by program under which the data were collected: circles for the 2009 program data and squares for the ongoing 2016 program data. The following color coding for symbols is used based on a comparison of the results to the screening criteria applied for the two programs as indicated below and provided in Section 2.1:

- Pink circles – PFOA is greater than 0.4 µg/L (EPA's 2009 Provisional Health Advisory).
- Yellow circles – PFOA, is equal to or less than 0.4 µg/L.
- White circles – PFOA is less than the reporting limits indicated in Table 1 of the *2016-2017 Residential Drinking Water Surveying and PFAS Sampling Program Status Update* report and in Figures 4B and 4C.
- Pink squares – PFNA is greater than 0.013 µg/L and/or PFOA is greater than 0.014 µg/L, and/or PFOS or PFOA plus PFOS is greater than or equal to 0.07 µg/L.
- Yellow squares – PFNA, PFOA, and PFOS are less than the screening criteria.
- White squares – PFNA, PFOA, and PFOS are less than the reporting limit of 0.002 µg/L.

All locations in pink indicate drinking water wells that exceed screening criteria and are qualified for an offer of treatment by Chemours. Figures 4B and 4C show that there are pink locations throughout and near the boundary of the surveying and sampling areas. Section 4 of the ongoing 2016 program SOPs provides information on the process by which owners of qualified drinking water wells were offered treatment to reduce exposure to PFAS from the drinking water.

Section 5 of this report provides information on the treatment status for each qualified well and the quarterly OM&M program for all granular activated carbon treatment systems installed. Section 7 of this report provides the proposed path forward.

5.0 Drinking Water Wells Qualified for Treatment

Based on the data collected during the 2009 program, one residential drinking water well qualified for treatment because the PFOA concentration measured was greater than the EPA's 2009 Provisional Health Advisory of 0.4 µg/L. A GAC treatment system was installed for that drinking water well in June 2009, and a quarterly OM&M program was developed and implemented for that treatment system and is shown in Figure 5.

Based on the data collected by Chemours for the ongoing 2016 program as of May 11, 2018, 143 drinking water wells are qualified for treatment because these wells have concentrations of PFNA, PFOA and/or PFOS above the screening criteria identified in Section 2.4. Once a drinking well was identified as qualified for treatment, the steps identified in Section 4 of SOPs submitted on May 15, 2018, were followed. Not all residents accepted the offer of bottled water and a few residents declined the offer of treatment altogether (see Section 5.4 below). In addition, there was one resident who accepted bottled water as an interim measure until such time as the new well he will be drilling is installed (see Section 5.3 for additional details).

Table 5 provides a list of the qualified wells and the treatment status. Figure 5 shows the location of the 143 drinking water wells identified during the 2016-2017 programs qualified for treatment and provides the following:

- The 128 locations for which GAC treatment systems were offered and installed, or installation is underway (Appendix G of the ongoing 2016 program SOPs provides the GAC Treatment System Installation, Operation, and Maintenance Agreement used)
- The eight locations for which PWS connections were offered and connections were completed or are underway (Appendix E of the ongoing 2016 program SOPs provides the PWS Connection Agreement used)
- The one location where bottled water is being delivered as a temporary interim measure
- The two locations where offers of treatment were declined
- The four locations for which treatment has not been installed

Additional information on each of these treatment options is provided below[5].

5.1 GAC Treatment System Installation and the Operations, Maintenance and Monitoring Program

Of the 143 drinking water wells qualified for treatment, 128 well owners were offered installation of a residential GAC treatment system. As of May 11, 2018, 119 GAC systems have been installed and the other nine are in progress (see Figure 5). Following installation of a GAC treatment system, the drinking water well was incorporated in the OM&M program in the quarter following the installation.

Prior to the third quarter of 2016, there was only one GAC treatment system installed, which was installed under the 2009 program. Between June 2009 and the third quarter of 2016, samples were collected from after the first carbon bed (BED1) and after the

[5] Documentation for GAC installations, PWS connections, declines, and bottled water are provided under separate cover as this information contains PPI.

second carbon bed (BED2) on a quarterly basis, although for a time period, only BED2 (which is representative of the treated water being consumed by the residents) was sampled. A prior-to-treatment sample was also collected in the third quarter of each year. Samples collected were analyzed for PFOA. A carbon change out was performed in July 2015 because the system had been in operation for five years at that point.

Only two GAC systems required sampling in the fourth quarter of 2016, the system installed in 2009 and the one system installed in the third quarter of 2016. BED1 and BED2 samples were collected and were analyzed for PFNA, PFOA, and PFOS. The GAC system OM&M program currently underway was fully developed during the fourth quarter of 2016 and was implemented during the first quarter of 2017.

Under the current OM&M program, quarterly monitoring consists of two samples: BED1 and BED2. BED1 is collected from the sample port after the first carbon bed. BED2 is collected from a sampling port after the second carbon bed and is representative of the treated water used in the residence. BED1-D, a field duplicate sample, may be collected from the GAC system at the same time as the BED1 sample for quality control. The BED2 sample will be analyzed if any of the following criteria are met in the BED1 sample:

- The PFOS, or PFOS plus PFOA concentration is greater than or equal to 0.070 µg/L.
- The PFOA concentration is greater than or equal to 0.014 µg/L.
- The PFNA concentration is greater than or equal to 0.010 µg/L.

The well owner will be contacted and arrangements will be made to replace the carbon in BED1 if any of the following criteria are met in the BED2 sample:

- The PFOS, or PFOS plus PFOA concentration is greater than or equal to 0.015 µg/L.
- The PFOA concentration is greater than or equal to 0.005 µg/L.
- The PFNA concentration is greater than or equal to 0.002 µg/L.

Carbon beds will be replaced every five years if the change out criteria are not reached within five years. In the third quarter of each year, a sample will also be collected from a sampling port prior to the treatment system and analyzed for PFOA, PFOS, and PFNA.

The last result for the first quarter 2018 OM&M program was just recently finalized and the *Chemours Chambers Works Survey and Sampling Program, Residential GAC System Results - 1Q18* report was submitted on June 5, 2018.

5.2 Public Water Supply Connection

Of the 143 drinking water wells qualified for treatment, eight were located in the vicinity of a PWS water line [in this case New Jersey American Water (NJAW)] and connection to the PWS was offered. Locations of PWS connections are provided in Figure 5. One resident whose well qualified for treatment was in the process of connecting the residence to the NJAW when the well was sampled. By the time the final results were available, the connection had been completed. Treatment offered to this resident was reimbursement of the PWS connection costs.

5.3 Bottled Water

One resident with a qualified drinking water well who was offered GAC treatment informed the Chemours representative that within the next year, he was planning on demolishing the residence and then rebuilding a new residence, including installing a new drinking water well. Therefore, the resident accepted an offer of bottled water until such time as the new well is installed and sampled. The new well will be sampled for the 14 PFAS listed in Table 1. If the well is qualified for treatment based on the screening criteria for PFNA, PFOA, and/or PFOS, a GAC treatment system will be installed.

5.4 Treatment Offer Declines

Two residents declined the offers of treatment from Chemours by signing the decline paperwork provided with the results and offer letter sent when the data were final. The locations of these residences where owners declined treatment are shown in Figure 5.

5.5 Locations Where Treatment Is Incomplete

There are three residents whose wells are qualified for treatment, and treatment was offered and accepted, but who have become non-responsive to the Chemours representative implementing treatment. These three residents' contact information has been provided to EPA and NJDEP for additional follow up. In addition, there is one resident who accepted Chemours' offer of GAC installation, but the residence went into foreclosure and is now bank-owned. Chemours has notified the bank of the surveying and sampling program and has asked that they please notify the Chemours representative if the property ownership changes in the future so that the new owner can be given the opportunity to participate in the surveying and sampling program. These four locations are shown in Figure 5 as "Other".

5.6 NJDEP-Identified Treatment Location

On May 2, 2018, NJDEP requested that Chemours install GAC at an address that their sampling and analysis program showed was qualified for treatment. Chemours agreed and the installation was in progress by May 11, 2018. This location is shown on Figure 5.

6.0 Branched and Linear PFAS Study

Two principal manufacturing processes are used to produce compounds containing perfluoroalkyl chains: electro chemical fluorination (ECF) and telomerization. The ECF process results in a mixture of branched and linear PFAS isomers (chemicals with the same chemical formula, but different molecular structures); whereas, the telomerization process yields only linear PFAS isomers[6]. This section summarizes the results of a study conducted by Chemours to evaluate the distribution of select PFAS isomers in the area surrounding Chambers Works[7].

6.1 Background

ECF is a process that has been used by some companies to manufacture perfluoroalkyl organic compounds (3M, 1999). As an example of this process, organic feedstocks are dispersed in anhydrous hydrogen fluoride (HF) through which a current is passed. The length of time and strength of current will result in some or all of the hydrogen (H) being replaced by fluoride (F). Because carbon chains are broken and rearranged, this process leads to the creation of a mixture of both branched and linear perfluorinated isomers. Linear isomers are composed of carbon atoms bonded to only one or two carbons, which form a straight carbon backbone. Branched isomers are composed of at least one carbon atom bonded to more than two carbon atoms, which form a branching of the carbon backbone[8].

Telomerization is a process that has been used for the introduction of perfluoroalkyl components into organic compounds by some companies, including at the Chemours (formerly DuPont) Chambers Works (Buck et al., 2011). In this process, telogens, such as pentafluoroethyl iodide (PFEI), are reacted with taxogens, such as tetrafluoroethylene, to create perfluoroalkyl iodides (PFAI, also known as Telomer A). Because this is a polymerization reaction that proceeds over time and because the carbon lengths of the base stock can be varied, the PFAS compounds created by telomerization are only linear, and the final Telomer A product can be a mixture of carbon length compounds.

During the ongoing 2016 program, there were drinking water well samples that had detections of PFOS. Because PFOS is not associated with Chambers Works, these results indicate that at least one source of PFAS, unrelated to Chambers Works as a potential source, exists at those locations. As discussed in the PFAS CSM report, these potential other sources include the use and disposal of consumer and industrial products that contain PFAS, such as stain-resistant treatments on upholstery and carpets, cleaning products, fire extinguishers, and many other common items that frequently are present in homes and businesses and which could also contribute to PFAS in residential drinking water wells. In addition, there may be known and potential contributions from nearby industries, airports, fire stations and fire training area activities, and fire-fighting activities related to automobile accidents on the three major highways that cross the area.

[6] https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_naming_conventions__3_16_18.pdf
[7] The information presented here is based on data evaluation discussions between AECOM and Chemours.
[8] https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_naming_conventions__3_16_18.pdf

6.2 Methodology

To evaluate if additional evidence for other potential sources of PFAS exist in the drinking water near Chambers Works, besides the observation of detectable concentrations of PFOS at certain locations, a subset of 10 locations where GAC systems were installed was selected for sampling and analysis of branched and linear PFOA, PFOS, and PFNA. Detectable PFOS and branched PFOA and PFNA are indicative of PFAS sources not associated with Chambers Works. Linear PFOA and PFNA is associated with Chambers Works (although not necessarily at a specific sampling location or locations). However, linear PFOA and PFNA may also be associated with other sources, including PFAS of ECF origin. The 10 sample locations were selected based on geographic position with respect to the Chambers Works (see Figure 6), previously measured concentrations of PFOA, PFOS and PFNA, and where available, well depth information.

6.3 Results

The summary of detected results of the branched and linear isomer analysis and evaluation of the data are provided in Table 6. The laboratory reports are provided in Appendix H. Cells in Table 6 highlighted blue are values for the percent (%) branched and several ratios of the branched and linear concentration for PFOA, PFNA and PFOS that were calculated using the analytical results provided by the laboratory. Table 6 includes data for field samples, field duplicates, laboratory duplicates (QC), and laboratory replicate 2 (QC), as indicated. Concentration ranges and ratio ranges provided in the observations below include concentrations and ratios for the field sample only. The following observations can be made on the results and information presented in Table 6:

- Linear PFOA, PFOS and PFNA were detected at all 10 locations.
- For the branched isomers:
  - Branched PFOA (PFOA-Monomethyl) was detected in nine of the 10 locations and the per cent (%) branched ranged from 1% to 6%.
  - Branched PFNA (PFNA-Monomethyl) was detected in three of the 10 locations and the % branched is 1%.
  - Two types of branched isomers of PFOS were detected:
    - PFOS-Monomethyl isomers (isomers with a single branching methyl group along the carbon chain) were detected as an aggregate value in all locations, and the % branched ranged from 24% to 58%.
    - PFOS-Dimethyl isomers (isomers with two branching methyl groups along the carbon chain) were detected as an aggregate value in four locations, and the % branched ranged from 7% to 8%.
- For the calculated ratios:
  - The ratio of linear PFOA to PFOS shows the highest amount of variability between the 10 locations (from 6 to 86) although 3LakesideLn and 20LaytonsLake, which are geographically close to each other, both have relatively low ratios (6 to 8).

- The ratio of branched PFOA to PFOS for nine locations is relatively small (0.1 to 1.7), while the ratio for 591OrchardRd (4.3) is more than twice that of the rest of the locations.
- The ratio of total PFOA to PFOS shows that 3LakesideLn and 20LaytonsLake, which are close together, have similar ratios (3.4 to 3.9) to 185PennPedRd and 733HawksBridgeRd (6.1 to 8.1) although these locations are not near 3LakesideLn and 20LaytonsLake, while the other six locations' ratios range from 19.0 to 36.2.
- The ratio of linear PFNA to PFOA shows that 591OrchardRd has the lowest ratio (0.03), 733HawksBridgeRd has the highest ratio (1.23), and the other eight locations have a more narrow range (0.12 to 0.32).
- Comparing all four ratios versus geographic location shows that ratios for 3LakesideLn and 20LaytonsLake (which are located geographically near each other) and for 606CedarCrestDR and 591Orchard (which are also located geographically near each other) are similar, whereas the ratios for the other locations do not seem similar (see Figure 6).

6.4 Conclusions

From these observations, the following conclusions are made:

- The presence of PFOS, PFOA, and PFNA in both linear and branched isomers indicates that there are multiple sources, industrial and consumer, for the origin of these substances in the water samples. It is not presently possible to discern to what degree any given source contributed.
- The existence of PFOS in all 10 locations supports the existence of at least one PFAS source at each of these locations unrelated to Chambers Works as a potential source.
- The existence of branched PFOA and limited branched PFNA also support the existence of at least one PFAS source at each of these locations unrelated to Chambers Works as a potential source, which may or may not be associated with the source of PFOS at each of these locations.
- The variability in % branched PFOA, PFOS and PFNA and thus in the ratios calculated indicate that there may not be a single additional PFAS source, but that each location (other than the limited similarities at 3LakesideLn and 20LaytonsLake) is subject to unique conditions attributing to the concentrations.
- The variability in all four ratios versus geographic location also supports that there may not be a single additional source, but that each location (other than the limited similarities in 3LakesideLn and 20LaytonsLake and for 606CedarCrestDR and 591Orchard) is subject to unique conditions attributing to the PFAS concentrations.

7.0 Conclusions and Proposed Path Forward

This report presented the results from the recently completed Expanded Area 3 and provided a summary of the status of the ongoing 2016 program. It also provided an update of the OM&M program and the results and conclusions on the branched and linear PFAS study.

The conclusions presented in this report are as follows:

- Drinking water wells with exceedances of the applicable criteria are located throughout the ongoing 2016 program investigation areas.
- Exposure to PFAS in drinking water is reduced by the implementation of treatment (GAC systems, PWS connection, or bottled water) when accepted by the well owner.
- The branched and linear PFAS study conclusions are as follows:
  - The presence of PFOS, PFOA, and PFNA in both linear and branched isomers indicates that there are multiple sources, industrial and consumer, for the origin of these substances in the water samples. It is not presently possible to discern to what degree any given source contributed.
  - The existence of PFOS in all 10 locations supports the existence of at least one PFAS source at each of these locations unrelated to Chambers Works as a potential source.
  - The existence of branched PFOA and limited branched PFNA also support the existence at least one PFAS source at each of these locations unrelated to Chambers Works as a potential source, which may or may not be associated with the source of PFOS at each of these locations.
  - The variability in % branched PFOA, PFOS and PFNA and thus in the ratios calculated indicate that there may not be a single additional PFAS source, but that each location (other than the limited similarities at 3LakesideLn and 20LaytonsLake) is subject to unique conditions attributing to the concentrations.
  - The variability in all four ratios versus geographic location also supports that there may not be a single additional source, but that each location (other than the limited similarities in 3LakesideLn and 20LaytonsLake and for 606CedarCrestDR and 591Orchard) is subject to unique conditions attributing to the PFAS concentrations.

The proposed path forward for this ongoing project is as follows:

- Continue to provide EPA and NJDEP with ongoing 2016 program updates on approximately a monthly basis.
- Continue to provide offers of treatment for qualified drinking water wells based on finalized results for PFOA, PFNA, and PFOS that exceed the applicable criteria.
- Continue to offer sampling to well owners that call the Chemours representative and to sample wells qualified for sampling

- Continue to perform the actions as described in the ongoing 2016 program SOPs (when approved) for residents:
  - With wells not qualified for treatment based on the PFOA, PFNA, and/or PFOS results
  - Who have not responded to Chemours' offer to sample or resample qualified drinking water wells
- Continue OM&M program in accordance with ongoing 2016 program SOPs (when approved).
- Implement the additional follow up activities for residents as described in the ongoing 2016 program SOPs (when approved).
- Meet with NJDEP and EPA to present the results of Chemours' evaluation of available PFAS data, which include the following:
  - Chemours Chambers Works Complex (Chambers Works; located in Deepwater, New Jersey) off-site monitoring well data from 2009, 2010, 2014, and 2016
  - Chemours off-site residential well data from the ongoing 2016 Residential Drinking Water Well Surveying and PFAS Sampling Program (ongoing 2016 program) finalized through May 11, 2018
  - NJDEP Solvay/Publicly Funded Perfluorinated Compound (PFC) Study data for Gloucester and Salem Counties
  - NJDEP response to online public request for public water systems (PWS) data in Gloucester and Salem Counties

8.0 References

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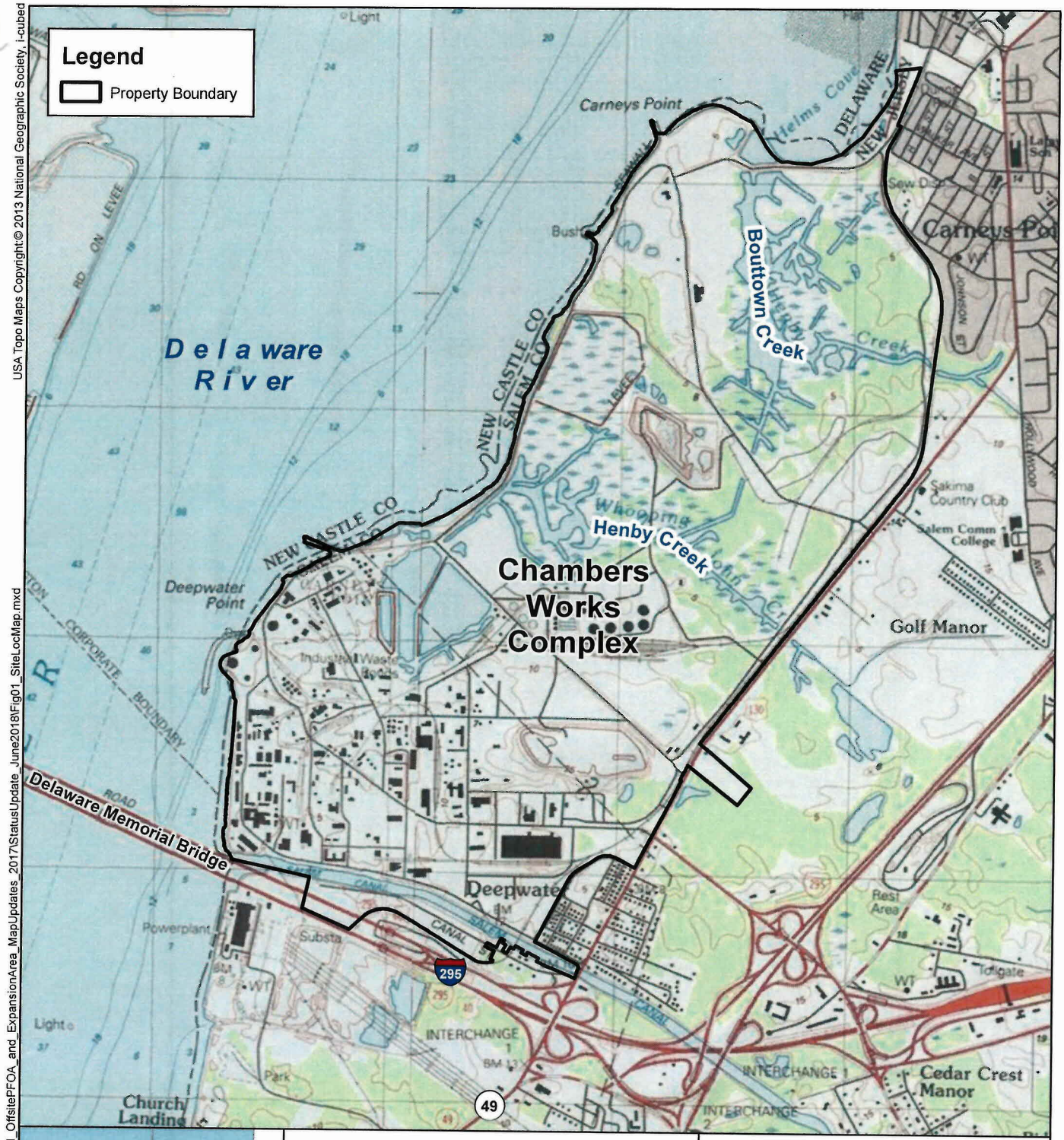

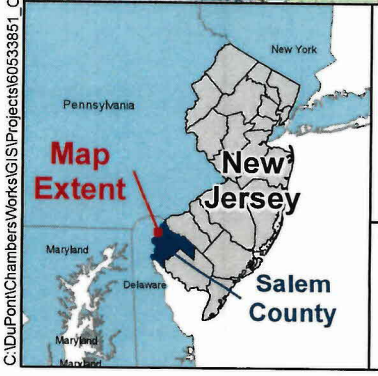

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SITE LOCATION MAP

ONGOING 2016 RESIDENTIAL DRINKING WATER WELL SURVEYING AND SAMPLING PROGRAM
CHEMOURS CHAMBERS WORKS COMPLEX
DEEPWATER, NEW JERSEY

TASK NUMBER:	PROJECT NUMBER:
18005	60554517
DESIGNED BY: K. L. DAVIS	DATE: 6/4/2018
DRAWN BY: C. DUFFY	FIGURE NUMBER: 1
DATA QUALITY CHECK BY: M. MCBRIDE	

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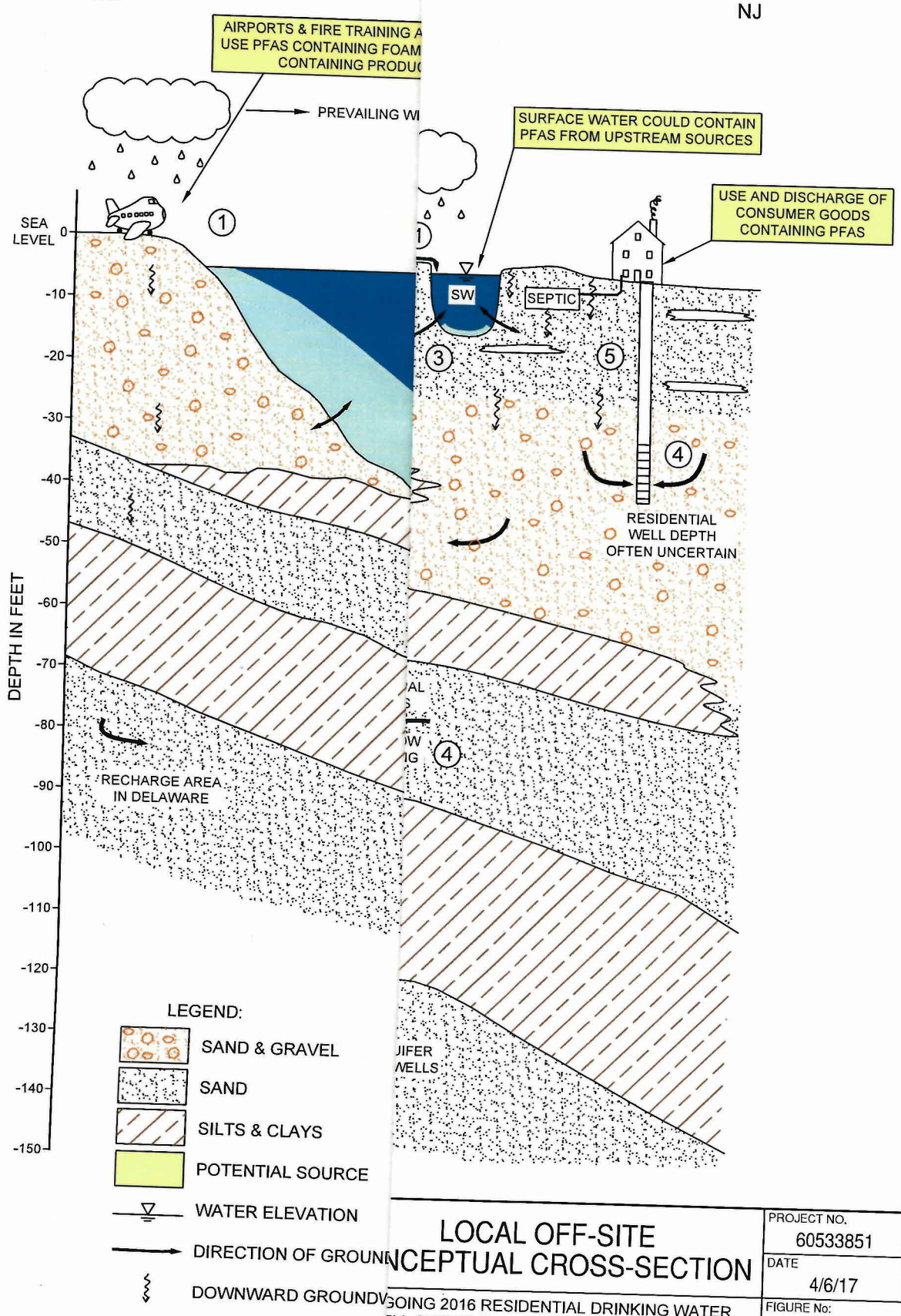

LOCAL OFF-SITE
NCEPTUAL CROSS-SECTION

GOING 2016 RESIDENTIAL DRINKING WATER
ELL SURVEYING AND SAMPLING PROGRAM
HEMOURS CHAMBERS WORKS COMPLEX
DEEPWATER, NEW JERSEY

PROJECT NO.	60533851
DATE	4/6/17
FIGURE No:	2

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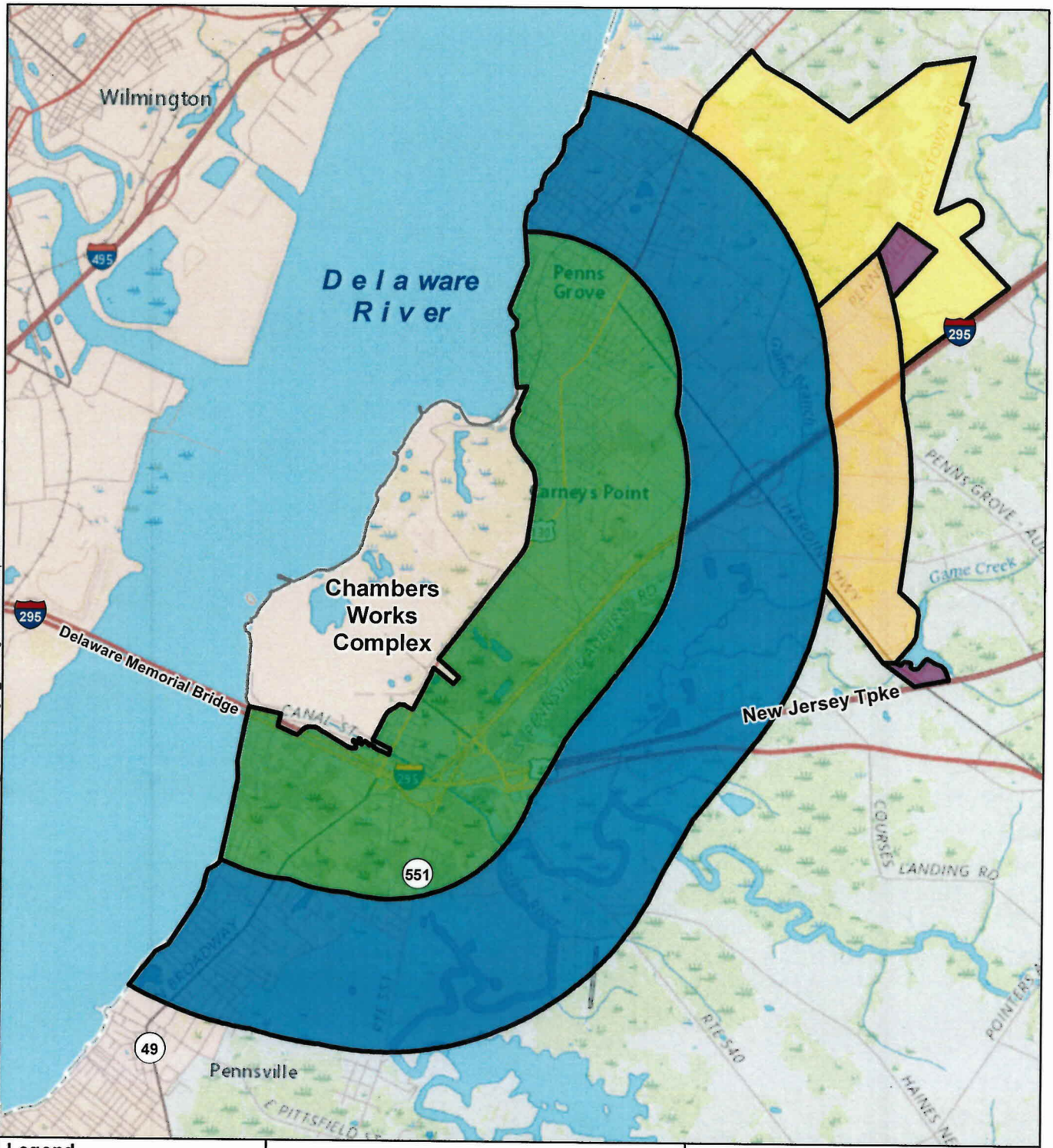

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Legend

- Property Boundary
- 1-Mile Radius Area
- 2-Mile Radius Area
- Expanded Area 3 (Approximate)
- Expanded Area 2 (Approximate)
- Expanded Area 1 (Approximate)

USGS TNM Topo Base Map Credits: USGS The National Map - National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line and USFS Road Data

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INVESTIGATION AREAS MAP

ONGOING 2016 RESIDENTIAL DRINKING WATER WELL SURVEYING AND SAMPLING PROGRAM
CHEMOURS CHAMBERS WORKS COMPLEX
DEEPWATER, NEW JERSEY

TASK NUMBER:	PROJECT NUMBER:
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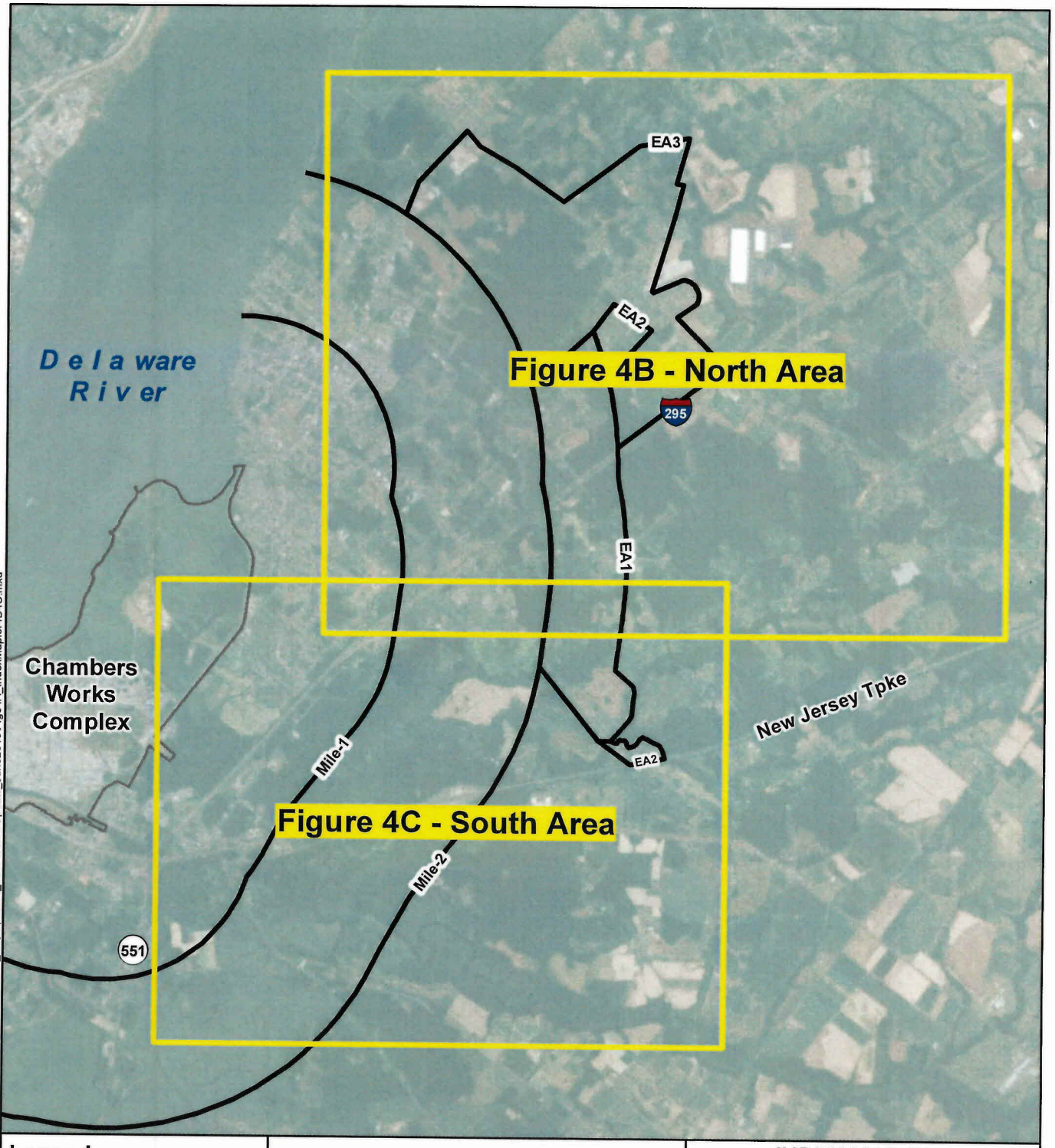
DESIGNED BY: K. L. DAVIS	DATE: 6/11/2018
DRAWN BY: C. DUFFY	FIGURE NUMBER: 3
DATA QUALITY CHECK BY: M. MCBRIDE	



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Legend

- Investigation Area Boundary
- Index Area
- Property Boundary

Notes:
Sampling locations in the overlap area of Figures 4B and 4C are posted on Figure 4C.

Metro 2017 Aerial Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.

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INDEX MAP FOR FIGURES 4B AND 4C

ONGOING 2016 RESIDENTIAL DRINKING WATER WELL SURVEYING AND SAMPLING PROGRAM
CHEMOURS CHAMBERS WORKS COMPLEX
DEEPWATER, NEW JERSEY

TASK NUMBER:	PROJECT NUMBER:
18005	60554517
DESIGNED BY: K. L. DAVIS	DATE: 6/8/2018
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